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The Question of the Guns as now debated

BY

STUART RENDEL

Erratum.

For Krüpp *throughout read* Krupp.

Printed by
SPOTTISWOODE & CO., NEW-STREET SQUARE, LONDON
1875

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PREFACE.

THE WRITER of these pages has been associated with the subject of Rifled Artillery for many years.

In 1862–63 he followed closely the investigations of the Parliamentary Ordnance Committee. In 1864–65 he attended the experiments of the Armstrong and Whitworth Committee, of which he became a member.

In 1866 he began his practical acquaintance with Foreign Artillery by attending a trial of the Krüpp 9-inch gun in Russia, and sitting at a discussion of the Artillery Committee there—a privilege accorded to him in Austria also.

Since that date his intercourse with leading Continental artillerists, as well as with our own Ordnance Departments, has been active and unbroken.

As a member of the Elswick firm, he has special knowledge of and natural bias towards the artillery of Sir W. Armstrong, including under that head the

modifications which constitute what is known as the Woolwich system. But his present object is a fair statement of the general question, and not the advocacy of any particular system.

His acquaintance with Gunnery at home and abroad being real, personal, and of long standing, will, it is hoped, gain for him a hearing.

June 14, 1875.

I.

ANYONE who desires to take a comprehensive survey of the Artillery of Europe and America, should at once see that the question,—Which is the best Gun, and in what country has Artillery made the most progress—is eminently a practical one, and that the investigation, practice, and experience of this country in regard to Heavy and Naval Ordnance exceed those of all other countries put together. Next, he should perceive that no country claims to have the best possible gun. The pattern adopted by each is in every case the result of compromise, and of a nice adjustment of the balance of advantage and disadvantage, as viewed by the respective Ordnance authorities, and as well from a political and economical as from a technical point of view. Then he must take into account that no country has been so unfettered in its choice, either by economical considerations, or want of mechanical skill, experience, and productive power, as this country.

Further, he should recognise the advantage of England, due to its priority of start in the investigation, and

the greater incitement to which this country is subjected, from the fact that the Gun question is really more vital to this, the chief maritime and industrial Power of the world, than to any of the chief military Powers of Europe. There is yet another circumstance attending the relative position of England and other countries to which due weight should be given. It was in England first that the leading civilian mechanics took up Gunnery, and broke down in a very large measure the natural jealousy of extraneous aid and intervention, and the exclusiveness of the Military and Naval Services. Since that date there has been—in spite of the existence here of Government manufactories—free-trade in gunnery to an extent unparalleled abroad, where the policy appears still to rule, that there is danger in encouraging civilian interference and manufacturing rivalry, and in permitting the character of adopted weapons to be lightly assailed. Here, the accepted system has had to push its way to the front in open, fair, and general fight, and is still pursued by even distanced competitors as well as fresh rivals, who, however hostile to one another's views, combine heartily, and by their combination acquire strength, in attacks on the Government system, whenever, as must often occur, the smallest opening offers itself. Moreover, the interest of the public in Gunnery questions, which is far more lively here than elsewhere, the ability of the journalists, the ease with which every adverse fact is elicited by means of Parliamentary returns (unknown abroad), all keep

alive a constant excitement. They furnish to a foreign critic ample material for discrediting our whole course of conduct in Gunnery, and they undoubtedly do much to mislead our neighbours if not ourselves. Yet of course they are stimulants, and keep our authorities and manufacturers incessantly active and alert.

Again, it should not be difficult to see that two dominant principles have guided the various authorities, who have from time to time ruled the question of Artillery in this country—viz., security in the guns, and simplicity in their working and equipment. Almost all the mystery about Gunnery is now, happily, dissipated. The principles upon and within which velocity, range, penetration, accuracy, shell-power, &c., are obtained are now generally understood, and the day for secret nostrums is nearly over. Given a certain weight of material, these qualities in the required proportion or combination can be secured to a gun without recourse to any magic as to metal, rifling, or loading, and subject to scientific principles well established and clearly formulated. But while such qualities are within comparatively easy reach, and by various ways, security still continues the vital and critical characteristic of a rifled cannon. In whatever form moulded towards the ends required, the gun must be moulded strong enough—must be secure.

Now, if this country desired a secure construction, a strong and reliable gun, certainly it had also, beyond all other countries, the power to obtain what it wanted. It

was free to choose amongst all known metals and methods of manufacture, and to this day remains free. Meanwhile, distinguished advocates of every material and system of construction have never been wanting to the country, and neither time nor money has been stinted in the investigation of their propositions and in the trials of their guns. To this day no country has made such effective use of cast-iron for modern artillery as we have in the case of the Palliser guns, while there is nothing whatever to show that the steel guns of Sir Joseph Whitworth are inferior in material or manufacture to any steel guns in the world. Yet, with a free choice before us, and the freest and fullest investigation behind us, we have adhered to the wrought-iron coil construction of Sir W. Armstrong for our guns; and of the honesty, at any rate, of our decision there can be no ground for question.

Compare this position of ours with that of other countries. It is certain that no other Government can obtain at home the wrought-iron coiled guns.* Their choice

* A French writer, discussing the different systems of manufacture in Europe and America, says, 'All honour is due to Sir William Armstrong for the coil principle by which he has well upheld the honour of the metallurgists of England'; and 'the solution he has given to the problem is to be found in the profound knowledge possessed in England of how to work wrought-iron.'

'In other countries they can make cast-iron and steel, but it is thought that it is only in England that they know how to work wrought-iron; and if it can be shown that laminated iron, forged and adapted in a certain way, is the best material for guns, the

has, in fact, been restricted to steel, or a combination of steel and cast-iron; and they have accordingly, without exception, selected steel, or steel and cast-iron jointly, just as manufacturing convenience dictated.

Furthermore, it is to be noticed that our freedom of choice, and our confidence in the versatility and resource of our manufacturers, has led to our testing the question of the security of gun in a manner altogether unknown abroad. We have never spared our guns. We have gone on using 'brutal' powder long after the discovery of forms of powder less dangerous to the gun and equally effective for all useful purposes. We still prove all our guns as we prove boilers and bridges, and as every Government proved the old smooth-bore guns—by submitting them to abnormal strains. Abroad the case is very different. Very early in the history of Rifled Artillery, both the American and Russian artillerists —committed the one to the disastrous Parrott system, and the other to the nearly equally disastrous solid steel Krüpp guns—set to work not to get stronger guns but to get milder powder, and at once and for ever renounced the

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demonstration is evident of the superiority of England. The advocates of the English system assert that it is more easy to tell the state of the gun, and that the cylinders so obtained are always so much better than when forged in a solid mass. Whatever be the truth, we agree with Colonel Treuille de Beaulieu, who thinks that this manufacture is difficult and complicated. However, these guns have one great quality—they do not burst without warning; the expansion and the disruption of the parts are visible before the rupture is complete; and this is certainly an advantage.'—'*Etudes sur l'Artillerie moderne.*'

use of the 'poudre brisante.' Manufacturer's proof by extra charges is practically unknown abroad with heavy rifled guns.*

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* In 1872 the Russian Ordnance officials were startled by the explosive failure of Krüpp heavy guns with service charges. Investigation satisfied them that the failures were due to the unexpected existence of flaws of a peculiar character. It appeared that the attempt to obliterate by pressure cavities in steel served occasionally to create flaws of imperceptible thickness, but widely diffused, the surfaces of which, though in the closest contact, were not united. They learnt that here this defect was well understood, and that it was the practice to try to elicit its existence in our steel inner tubes by pumping water into them before they were used in the manufacture of guns. Water would enter where no other searcher could, and on the drying of the surface of the steel a thin film oozing out revealed the defect, if any portion of it touched the surface of the tube. The Russian officals, following up this idea, conceived the plan of testing their complete gun by as high a water-pressure as could be produced, and they obtained from the Elswick firm some hydraulic machines capable of producing a water-pressure of seven tons to the square inch. One of these is now in use in the principal Government gun-factory. Another is provided with appliances enabling it to be transported to the different forts, and applied to the heavy guns in position. The strains produced by these machines are static; and the guns, if fired at all, must, by the admission of the Russian authorities themselves, support concussive strains of at least 15 tons. From 18 to 25 tons is considered a moderate powder-pressure in this country, and our guns have occasionally been subjected to local strains of from 40 to 60 tons. Thus the Ordnance Departments of Russia—who have been practically the founders of Krüpp's factory and fame, by their confidence in steel, and in his steel in particular—find themselves in this position: that it is thought prudent to put guns of the highest consequence, and actually mounted in their forts, through a preliminary insignificant water-test, rather

The foreign artillerists may be right in thus declining the use of our severe powder, and objecting to submit every gun manufactured to proof by extra charges. But, at any rate, the hardihood with which we have adhered to practices unnecessarily severe upon our ordnance speaks volumes for our independence and confidence, while the withdrawal of foreign guns from these tests renders impossible any conclusive comparison of the foreign with the British gun for ultimate and enduring power. Of course if our guns can fire the stronger powder, they can *à fortiori* fire the milder powder, and in the larger calibres they are now doing so; but foreign guns cannot, it would appear, support the strong powder, and they thus give no evidence of that surplus of strength which we deem requisite to provide against defects of manufacture and accidental strains in use.

It may be said that security is one thing, and durability another, and that our construction, while having the merit of giving notice of failure, may have the demerit of failing too soon. But do our guns fail too soon? Our field and siege artillery have proved simply indestructible, and it is needless to recount the thousand upon thousands of rounds fired from even individual guns without a single failure.

Our experience of the endurance of our heavy guns is no doubt less considerable, but so also are our require-

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than submit them without such test to the ordeal of a single service round.

ments. People are apt to talk of the hundreds of rounds which heavy guns may be called on to fire in an engagement or campaign, without sufficiently reflecting upon the enormous difference between great and small guns.

Our Admiralty only supplies 85 rounds of assorted ammunition to each broadside-gun of seven inches calibre and upwards. A few chase-guns have 105 rounds. The turret-guns are in some instances supplied with 120 rounds in peace-time; their full complement in war-time is 170 rounds. The ammunition of each of the 38-ton 12½-inch guns proposed for the 'Thunderer' weighs over 71 tons.

Now, it appears from an official return recently called for in Parliament,* that no less than 368 of our 7-inch guns—guns that will pierce at 1,100 yards distance the greater number (63) of the ironclads afloat†—have fired over 100 rounds each; five of them over 1,000 rounds each; one, 2,342 rounds. The average of eighteen is 888 rounds each. *One* out of the 368 guns has been provisionally condemned; another, that which has fired 2,342 rounds, had a new inner tube after firing 1,770 rounds.

The 8-inch 9-ton guns are less largely introduced and employed, yet 89 of them have fired upwards of 100 rounds each, going as far as 753 rounds in one case, and 1,918 rounds in another, and not one of them is unserviceable.

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* See Mr. Hanbury-Tracy's return of this Session.

† See diagram prepared by Captain W. H. Noble, R.A., and circulated officially August 1873.

The 9-inch 12½-ton gun may be called the standard heavy gun of our service. Of these important guns, 111 have fired above 100 rounds each, 23 of them over 400 rounds, five over 1,000 rounds. The average of twelve guns is 818 rounds apiece, and not one of these 111 guns is pronounced unserviceable.

Of the 10-inch 18-ton guns—which can penetrate, with two or three exceptions, every ship afloat—fourteen have fired over 100 rounds; two, 693 and 889 rounds respectively; the latter gun was retubed after 534 rounds. Another gun, which has fired 425 rounds, requires a new tube; the rest are serviceable.

Of the 25-ton guns, which will penetrate every ship afloat at the water-line, but of which we have but few in use, eight have fired from 100 up to 485 rounds; one of them requires a new inner tube.

Our 35-ton gun, of which only six are yet in use, has been fired 207 rounds.

The experimental 38-ton gun, the largest yet known to us, and of which but two are in the service, has fired 247 rounds; many of these rounds with 140 lbs. of powder, and projectiles of 800 lbs. weight—charges unknown in any other country.

Here then is the evidence of nearly six hundred (592) heavy armour-piercing guns, every one of which has fired, at the lowest, 20 per cent. more shotted rounds than its full complement as a broadside-gun, and at the least its own weight in ammunition, and no inconsiderable portion of

which have fired ten times that quantity, while but one has been condemned. Instead of being able to produce upwards of fifty heavy rifled service guns that have fired on an average over 700 rounds apiece, the Continental Powers, which do not conceal their successes, may be challenged to produce over five such guns showing such endurance, while their failures, as compared with ours, are apparently in an inverse ratio: not one of our guns, once admitted to service, has burst.

In regard then to security of guns, the mind of this country may be said to be justly at rest, and thus our authorities have succeeded in giving effect to their first main effort and principle—security in the gun.

Every step made in gunnery science, every advance and change in the art of war, shows out more and more the importance of our having recognised security of structure as the cardinal virtue of a gun. The growth of guns in mere size, their use in confined and crowded spaces, and in connection with complicated machinery, their reduction in numbers and consequently increased value, make it more than ever essential that they should under no circumstances be subject to sudden or explosive failure. This security we, and we alone, have; and we owe it, be it here said, to Sir William Armstrong.

Next in importance to security of gun has come simplicity of gun and equipment in the mind of the British artillerist; and it is due to the dominance of this principle of simplicity that the muzzle-loading system of ordnance

has been gradually established in almost every calibre and service.

The question between muzzle-loading and breech-loading is one of great complexity, but it may be said that it mainly turns upon the value to be given to the properties peculiar to breech-loading guns, when weighed against the quality of simplicity in which the muzzle-loader is of necessity superior. Of course there has been, is, and will be room for the nicest balance of advantage and disadvantage, theoretical and practical; and no competent artillerist will ever pronounce other than a cautious judgment, and one carefully restricted to present time and circumstances, and divided, it may be, in favour of breech-loading for some calibres or uses, and in favour of muzzle-loading for other uses or calibres. There is then ample room for valuable discussion, and for the elaboration of the many particulars and considerations that should find place in any thorough investigation by an expert of this confessedly difficult and always open question.

The hostile critic of British service ordnance appears to see nothing of all this. Such details as, for mere example, the value of an effective time-fuze for field service, or the cost to the breech-loading field-gun of its sacrifice of such a time-fuze, he discards in favour of arguments more popular, more easily handled, and more sweeping. Our preference for muzzle-loading is the result, as he suggests, of a false start, and of mingled prejudice and pique. We burnt our fingers with the breech-loading system of Sir W.

Armstrong, and since then will have nothing more to do with breech-loading, and we must be wrong, because all other nations, who of course are not and have had no reason to be so blind and bigoted as we are, have adopted breech-loading.

It is a short method of dealing with a doubtful issue to assume that the one side is governed by mere sentiment, and the other by pure reason. But decisions made under such assumptions obviously leave us just where we were.

The advocate of the English artillery might of course retort and say of its only real rival: Krüpp began with muzzle-loaders. They burst, and it is well known that breech-loading was adopted by him primarily to save—as he thought—the guns; since then he has never ventured to bring forward a muzzle-loading gun. He has been wedded to one system of loading, and even to one general form of breech-mechanism, and those who have followed him have never had any independent choice between muzzle-loaders and breech-loaders. It would be at least as true then to argue that Krüpp has adopted and adhered to breech-loading guns because of his early failures with muzzle-loading guns, as to argue the converse in the case of this country. But what are the facts? England, which began with the muzzle-loading rifled guns of Lancaster, next adopted the breech-loading Armstrong gun, yet had hardly done so before Armstrong brought forward a muzzle-loader with a declaration of complete impartiality. Meanwhile Sir Joseph Whitworth was halting between the two systems, the first guns of his

construction being breech-loaders, while those with which he won his laurels were muzzle-loaders. Thus this country was from the first free to choose, and in fact divided its choice, deciding upon breech-loading for small guns, and upon muzzle-loading for large guns—a decision which was certainly right at the time, and which, right or wrong, at any rate disposes of the imputations of prejudice in favour of either method of loading.

But the argument of the foreign critic and of some domestic opponents is, that it was the failure of the Armstrong breech-loading which for ever disgusted us with breech-loading, and that to save our credit we threw the blame on breech-loading.

The foreigner and his friends little understand our English love of an open fight and fair-play. Had Armstrong's method been alone in fault, his failure would have been Whitworth's or any other man's opportunity. Those who know anything of the stir and spirit of competition that animated this country on these questions at the time, will at once admit that had the imperfections of the breech-mechanism been the real grievance against the Armstrong breech-loaders,* a score of alternative methods

* From this statement should be excepted, perhaps, the case of the Armstrong 110-pr. breech-loading guns. Upon these guns the Parliamentary Ordnance Committee of 1864 reported as follows:—

'As to the 110-pounders, it is on all hands admitted that, although useful as chase guns, they ought not to be introduced into the naval service as broadside guns. They were originally required for use against wooden ships, and, whilst not sufficiently

would have been brought forward to displace it. But the fault of the Armstrong breech-loading field-gun, and its only fault, was that it was not a muzzle-loader; and it was supplanted by a muzzle-loader on arguments carefully set forth by many Committees, which show that the muzzle-loader found favour from preference for the qualities peculiar to muzzle-loaders—for simplicity of parts and of stores, of handling and of ammunition—from a sense of the special importance to the country of an arm fitted for the widest distribution, in every climate and for the rudest use —from a belief that any superiority in accuracy, or

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powerful for penetrating iron-plated ships, are as yet imperfect for general naval service, owing to the difficulty of managing and manufacturing the vent-piece. Nevertheless, the 110-pounder is considered by naval men of eminence in their profession as a most valuable weapon in its present proportion to the armament of a ship; and the Duke of Somerset is of opinion that the Navy has not got too many of them.'

It is too often forgotten, not only that the 110-pounders were designed to order hurriedly, and to meet an immediate and urgent want, but that they were introduced before the importance of armour for naval use was fully realised. They were *shell*-guns, and it was in view of their formidable character as shell-guns that armour-plates became a necessity, to meet the sailor's cry, 'For God's sake, keep out the shell!' With the extension of the use of armour they became obsolete. The 20-pr., 40-pr., and 70-pr. Armstrong breech-loaders are excellent examples of breech-loading guns. The 40-pr. in particular is a favourite with the Navy. Certainly these guns have not discredited breech-loading with us. And it is noteworthy that the 110-pr. finds a place in the latest designs of our Director of Fortifications, who selects them for certain landward positions.

rapidity, or shelter claimed for the breech-loader was too trifling in degree to be valued at the heavy cost of greater complexity of gun, of store, and of drill. Such arguments as these are at least worth recognition and treatment as fair, if not convincing. They may not satisfy every home and foreign critic that our decision was right, but they should at least assure them that it was made in good faith, and that this convenient aspersion of the Armstrong breech-loader, however clever and cutting an explanation of our choice, is as unworthy as it is irrational.

Putting aside all accusations and counter-accusations of prejudice, the question remains, Whether we were and still are right in elevating simplicity of gun, and of equipment, into a first place as a guiding principle in the selection of a system of artillery? Undoubtedly simplicity may be purchased too dear, but it may be maintained with great force that all our experience tends to show the wisdom of tenaciously maintaining simplicity as the primary merit of a gun. Upon this question turns the judgment for or against us in reference to our rejection hitherto of breech-loading, since, whatever may be the advantages of breech-loading, there is no system possible of breech-loading which does not largely invade, both as to gun and equipment, the principle of simplicity. This is why we have laid it down, that the burden of establishing greatly superior advantage lies in the way of breech-loading, and further, why we have kept well before us the fact, that even should the breech-loader at one moment, or for one service, or for one calibre,

possess a balance of advantage, it is in the nature of things that in the long run simplicity should be of first-rate value, while the countervailing advantage of breech-loading must necessarily fluctuate in value with time, circumstance, and scientific progress. The course of English gunnery has been shaped by these views. Sir W. Armstrong has plainly stated that he in the first instance adopted the breech-loading system simply because he then found it necessary to insert a projectile at the breech-end of the gun, as it would not have entered the muzzle. No doubt that first gun presented all the advantages claimed for breech-loading in a high degree, but no doubt also there was at that time no muzzle-loading rifled gun which could compete with it generally, and the breech-loader was selected of necessity, and not of choice. So soon as muzzle-loading systems of artillery had been matured (Sir W. Armstrong himself being foremost in this task), it became really possible to exercise a choice. We then chose a muzzle-loader for field artillery, and whether we were right or wrong, there certainly was neither occasion for prejudice nor room for any serious error of judgment in the adjudication on rival merits so evenly balanced.

At any rate, this may be confidently said, that we have little to learn from foreign experience that we do not know. We have compared the performance of our own muzzle-loading field-gun and the Krüpp breech-loading field-gun by actual trials and in the most careful manner, and those who have read the candid report of January 1872, of General Eardley Wilmot's Committee, will

be satisfied that whatever may be the relative value of simplicity, we have not purchased it at a sacrifice in any appreciable degree of any other good quality of a rifled field-gun. It is true that since that day the German field artillery is in course of entire remodelling, and that neither can we escape the necessity of change; but surely the very rapidity of the advance of gunnery science, and the frequent call for change, should make us cling more closely to those elementary principles, such as security and simplicity, which, having the greatest stability, may be expected in the end to win the day.

In the case of heavy ordnance the conditions are widely different, and yet, if the same principles are maintained, the result will probably be more favourable to the muzzle-loader than in the instance of the field-gun.

But to discuss the problem as it relates to the larger guns, it is necessary to enter a little into detail, and to set forth the advantages claimed as peculiar to breech-loading. These are, first, the power of using longer guns than can be conveniently loaded from the muzzle; secondly, the suppression of windage by the employment of tight-fitting projectiles, with all the concomitant advantages; such as, possibly, superior accuracy and, certainly, superior durability of the bore; thirdly, the protection given to the gun's crew by the circumstance of their loading behind instead of in front of the gun. It is clear that even assuming these advantages collectively as of first-rate importance, and outweighing the merit of simplicity, unless they can be shown to be inherent and

peculiar to breech-loading, the adoption of breech-loading on their account becomes a questionable step; for breech-loading presents grievous disadvantages, which are undoubtedly inherent and peculiar. However simple the mechanism, (1) it necessarily either adds to the weight and length, or detracts from the strength and power of the gun, so that for equal strength, power, and ballistic qualities the breech-loader is heavier and longer than the muzzle-loader. (2) In monster ordnance the breech-mechanism becomes so ponderous* as to be very slow in movement, and there is therefore, necessarily, a point at which the muzzle-loader will beat the breech-loader in rapidity of fire. (3) Again, while the breech-loader continues always more susceptible of injury, the muzzle-loader gradually becomes, from its mere mass, self-protecting in a high degree; (4) and, lastly, while the advance in size and power of gun is with the muzzle-loader almost unimpeded and unlimited, with the breech-loader the difficulties of service of the gun advance in an increasing ratio.

It cannot be wondered at that the British authorities and the wisest British artillerists, weighing the considerations on one side and the other, should feel an unwillingness to largely commit this country to a system of breech-loading heavy ordnance, the disadvantages of which were inherent to it, and the advantages of which might be at any moment secured for the muzzle-loader, and circumstances have already arisen which justify their caution and evince their

* The sliding wedge of the 12-inch Krüpp gun weighs about *one ton.*

foresight. Indeed, it would hardly be rash to assert that had the authorities adopted breech-loading for their heavy naval guns, they would at this moment be far more embarrassed by the question of reverting to muzzle-loaders than they are in fact troubled in considering their reply to the partisans of the breech-loader.

Take, for example, the first advantage of the breech-loader over the muzzle-loader, greater length of bore: mechanical loading, now a *fait accompli*, most undoubtedly places the heavy naval muzzle-loader on an equality with the breech-loader in this respect.* Next, as to the suppression of windage. The experiments with a muzzle-loading 12-ton gun rifled, like Krüpp's, on the polygrooved system, and with a particular form of adhering metal wad, have shown that it is perfectly possible to introduce shallow groove, to get rid of studs, and to suppress windage in the muzzle-loading guns with precisely the same beneficial results as in the case of the breech-loader. These results appear to be strongly confirmed by recent experiments in the United States, where upwards of 500 rounds have been fired from a 10-inch Rodman gun con-

* It may be said, 'True; but where is now the simplicity of the muzzle-loader?' To this the answer is, that the mechanism involved in mechanical loading is far simpler than any known mechanism for opening and closing the breech of a heavy gun; that it is wholly independent of the gun, as indeed the gun is of it, should need be; that it is not exposed like the gun; can be duplicated, absolutely protected, worked from a secure distance; in short, is almost on the footing of the turret engine, or even ship's engines, by means of which alone naval guns, whether breech or muzzle-loaders, can be taken into action.

verted into a rifled gun upon Sir William Palliser's system, and in which a soft metal wad gave perfect rotation to the projectile, and suppressed the windage. The remaining advantage of breech-loading, in regard to cover given to the men serving the gun, is now annulled by another feature of the hydraulic gunnery system, for on this system the crew are reduced indefinitely in number, and a child even might load the heaviest gun. Moreover, such men as are employed may be placed in a position of perfect security below deck.

In the meantime, while the breech-loader has lost the exclusive possession of its advantages, the muzzle-loader has already pushed very far its own peculiar advantages. It has enormously increased, is increasing, and will increase in size, and becomes with every increase less dependent upon the protection of armour. In fact, the armour of turrets carrying monster muzzle-loading guns is already being reduced in thickness upon this very ground.* It need no longer be waited upon in narrow quarters by a numerous crew. Of necessity it remains more powerful for any given weight than the breech-loader, less liable to derangement, cheaper, and with equal material and skill in construction stronger. Thus at this moment we enjoy the prospect, if not the realisation, of a complete victory over the breech-loading naval systems of artillery so largely adopted abroad; and we owe this prospect entirely to our steady maintenance of first principles, and our adherence to a policy dictated by

* The armour-plates of the 'Inflexible' are to be 22 inches thick at the water-line, but only 18 inches thick on the turret.

independence and common-sense in the matter of rifled artillery.*

II.

Yet, were it possible to satisfy some ordinary Englishmen by reasoning such as the foregoing that independence in choice, thoroughness in trial, and soundness in judgment have thus far guided the Artillery question in this country, there would still remain a majority who would refuse to judge for themselves, and prefer to accept such ready-made opinions as might fall in their way. Opinions thus gathered are almost by necessity adverse to the existing state of things. Who that knows us does not know the power of paradox, of pessimism, of proselytism at all

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* This country is interested, not only as a naval Power, in procuring a simple gun as being fittest for service afloat. As an insular power, with a large seacoast to protect, we are almost equally bound to provide a gun simple enough to be independent of a numerous and skilled crew. The difficulty of manning all the guns we may have to provide for coast defence is a serious one, and the necessity for devoting and training a large number of men to the duty of serving guns—which, however little used or wanted, must always in war-time be ready for use—and of providing for the maintenance of such men in isolated positions and in often cramped quarters, is very onerous. Breech-loading increases and perpetuates these burdens upon our resources, for it involves essentially both numbers of men and of skilled men, who must consent to be confined often in iron boxes, in inactivity and discomfort at every period of alarm. Muzzle-loading guns, worked, as it is now clear they can be worked, by mechanical appliances, rid us of all these difficulties at once.

times amongst us? Who does not know the high indifference of our public offices to common chatter? And if opinions are to be picked up in the club and street, who does not know that those which enliven the smoking-room and enlighten the lecture-room are almost exclusively the opinions of the *dilettanti*, of the disappointed, of the partisan, of the professional grumbler; and that, thanks to official reticence, the other side is heard but at rare and long intervals?

Thus it is that anxieties accumulate upon the public mind, always sensitive in matters affecting national security, until at length the period of panic inevitably recurs. Thereupon Parliament, which grows greedier of intervention in administration and readier to embarrass the Executive every day, hastily gives the signal for a general scare.

It was in this way that, seven years ago, an enthusiastic Rifleman, without the aid of a single sound argument or the concurrence of a single responsible artillerist, was able to seriously frighten the country, discredit our artillery, and compel a momentary retrogression in favour of American ordnance. A costly trial of the great 15-inch Rodman gun followed, and the agitation collapsed; but meanwhile a most false estimate of the American situation in the vital matter of ordnance,* and a most unjust depreciation of our

* The public may now know, from a report of a Joint Committee of Senate and Congress, dated February 15, 1869, that the situation of the United States was at that very time truly pitiable in the matter of ordnance; that 'each system of guns introduced into our service . . . . . has failed when submitted to the real test of

own position, had been brought about with an ease and levity equally astounding—and this, be it noted, at a grave juncture of our affairs in relation to America.

Once more we appear to be nursing a panic, and this time it is at the Krüpp breech-loading ordnance we have taken fright. What is the source of the present alarm? There are no new facts, there is no fresh evidence to justify it. The late war threw no light upon Krüpp heavy or naval ordnance, for no such guns were engaged in it; and

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service;' that 'experience has shown them to be inferior in range and penetration to the guns of foreign Powers, and unreliable as to endurance.' 'That the Rodman system of gun-making, while partially successful in smooth-bores and small calibres, has so far failed in rifles of large calibre as to show it to be unworthy of further confidence. Recent improvements in defensive works and armour-plating render heavy rifled guns the most efficient means of attack, and no system of fabrication which does not furnish such guns should be adopted or continued.' That 'the present system' of procuring ordnance 'has failed to answer the purpose for which it was designed, and the United States is in the position to-day of a nation having a vast coast-line to defend and a large navy without a single rifled gun of large calibre, and a corps of ordnance officers who have thus far failed to discover a remedy for the failure of the guns, or to master the rudiments of the science in which they have been trained at the public expense.' 'In the operations upon Morris Island,' says the Report, 'twenty-two large guns was the greatest number mounted at one time, yet fifty in all burst during the siege, as is shown by the evidence of General Gillmore. In the attack on Fort Fisher all the Parrott guns in the fleet burst, according to the report of Admiral Porter. By the bursting of five of these guns at the first bombardment forty-five persons were killed and wounded, while only eleven were killed and wounded by the projectiles from the enemy's guns during the attack.'

we know that the Krüpp field-artillery of the war is now being replaced by guns not merely different in pattern, but materially modified in structure. On the other hand, we have experienced no check. We have, indeed, made prodigious strides in gunnery without a semblance of failure.

The period of panic is, however, coming round. Old inventors have found new converts. Irrepressible orators have startled fresh audiences. The 'Times' is disquieted, and the present Parliament possesses some new professional gunners—not gentlemen sent to the House as being gunners, nor probably ever selected to aid in the solution of any artillery problem. Yet the House has, and likes to have and to hear, its own artillerists as well as its own ship-builder, and in good time its own engineer and doctor, &c. A hearing is an object of honourable ambition; so one or other of the artillerist Members is sooner or later found ready to present to the House a striking case for the exercise of its omniscient and omnipresent vigilance. A grave discussion of the rival merits of uniform and increasing twist of rifling ensues. The official Gunnery Departments are faintly supported by cautious chiefs, and the country is promised that fresh Committees shall revive dead controversies. Thus Parliament, after an exhibition of bewildering wisdom as an Artillery Court of Appeal, has the satisfaction of arresting the course of an infatuated officialdom and of sending it back to school.

Are we afraid of our own guns? Apparently not.

Are we afraid of foreign guns? Apparently yes, and because Europe bristles with guns.

Briefly, then, how does the foreign gun question stand? Take the field-gun first. No country has so deep an interest and so determined a desire to study the field-artillery question as France, and what does France say, after careful trials of many systems?

'Notwithstanding a few imperfections, the Woolwich '*matériel*, taken altogether, constitutes a first-class system 'of field-artillery.

'The Woolwich wrought-iron 9-pounder gun gave 'results which are not inferior to those of any gun actually 'in service in Europe. These results, however, can perhaps 'be surpassed. This is the end to be kept in view in the 'selection of a field-gun, and which must be attained in the 'case of our adopting a breech-loader. This method of 'loading, since it possesses practical inconvenience, must 'give, in compensation, notably superior results to the best 'muzzle-loading gun in order to be adopted.'

True, France intends to have a breech-loader, and our gun is a muzzle-loader; but her decision in this respect is a foregone one, as the Circular* of the Minister of War of August 5, 1871, discloses.

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* This Circular is too long for quotation, but in effect is an order to the Generals commanding districts to constitute commissions for the universal study of the question of the best field-gun, laying down certain essential conditions, one of which is that the gun shall be a breech-loader. Twenty-eight designs submitted in consequence of this Circular were selected for consideration, and the authors of ten of the twenty-eight, notwithstanding the circular, strongly urged the case for the muzzle-loader.—*Vide* 'Revue d'Artillerie,' June 1, 3e Livraison, pp. 225, 237.

It is notorious that national policy, rather than artillery science, forces breech-loaders upon France, to satisfy a popular explanation of her calamities and encourage hope from the change.

Germany is replacing the field-gun of the war. The Bohemian campaign was marked by disasters with German field-artillery: no less than six guns burst. The French campaign also was unfavourable to the strength of the German artillery *matériel*: twenty-seven guns were rendered totally unserviceable by their own fire; 210 guns were placed *hors de combat.** The *average* number of rounds

* H.R.H. the Duke of Cambridge referred to the failures of over 200 field-guns in the House of Lords on April 3, 1875, whereupon Herr Krüpp's English agent stated, in the 'Times' of May 17, that 'not one single piece of the Krüpp breech-loading guns gave way, and no casualty happened either with the field-guns or siege-guns.' On May 18 the 'Times' published the following remarks from L. G.:—'This assertion surprises me not a little, for, happening to be at Versailles in February 1871, I had the opportunity of conversing with some officers of high rank on the Headquarters Staff of the German army, one of whom, who certainly had every opportunity of being well-informed, told me that out of seventy long breech-loading 24-pounders in battery on the south-west front of attack, thirty-six had become unserviceable during the fifteen days' bombardment, of which number the greater part were damaged by their own fire; and that it was generally believed that had the French held out another week the German siege batteries would have been silenced, as most of their guns would have become unfit for use, in great measure owing to the weakness at the breech. Again, I believe it to be an undoubted fact, as I have it from the best authority, that during the short though severe campaign on the Loire and in Brittany, twenty-four of the field-guns (all breech-loaders)

per gun employed in the eighteen great battles of the war

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belonging to Prince Frederick Charles's army became unserviceable, chiefly from their own fire, and had to be replaced from Versailles. It does not, of course, by any means follow from these facts that the guns in question proved defective simply because they were breech-loaders; on the contrary, I believe that the defect lay principally in the metal of which the guns were constructed—a defect which German artillerists have been seeking to correct ever since the war. These facts, however—to which I challenge contradiction—are sufficient to prove that Herr Krüpp's breech-loaders are by no means as infallible as Mr. Longsdon appears to think, and that the much-vaunted *matériel* of the Prussian artillery in 1870–71 was neither so perfect as very generally believed, nor did it, as some think, establish the superiority of the breech-loader over the muzzle-loader.' 'Armed Science' wrote also to the 'Times,' on the same day, as follows:—'On the contrary, about 200 field-guns, as stated by the Duke of Cambridge, became either totally or partially unserviceable during the war. Only two or three of these guns were injured by the enemy's fire. The remainder failed through injuries to the breech-mechanism, escape of gas, or bursting of shells in the bore. About five per cent. of the above number were condemned as totally unserviceable during the war, and were replaced in the field. A large number were condemned as totally unserviceable after the campaign. Some became temporarily disabled, and were replaced during the campaign, but the majority were replaced in the field by the battery artificers. Of course some of these guns had fired a considerable number of rounds, but many of them failed after less than 200 rounds. The failures were, in several instances, due to want of care in serving the guns and maintaining them in a serviceable condition. Twenty-four steel breech-loading guns were thus rendered *hors de combat* in one day in the army of Prince Frederick Charles before Orleans, and the circumstance was reported by the Military Correspondent of the 'Times,' in his letter of January 3, 1871. It is also no secret that a considerable

was under forty-eight. At Sedan one field-gun burst.* The new field-guns of Germany and Bavaria are being hooped† or reinforced, like our own field-artillery, behind the trunnions—most convincing evidence that even the diminutive ingots of steel required for these small guns are not regarded by Germany itself with the requisite confidence.

Austria has not yet decided upon the pattern of field-gun, not having been quite satisfied with the sample gun submitted by Krüpp after the war.‡ Italy also is still

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number of the siege-guns in the batteries against Paris became unserviceable in their breech-closing apparatus, and had to be withdrawn from the batteries and either replaced or repaired in the workshops of the siege-parks.' Herr Krüpp's agent has not ventured to offer any explanation of the inconsistency between his sweeping assertion and these specific details. A large number of these unserviceable field-guns, and full statements of the number of rounds fired by each, with the cause and nature of its injuries, were seen at Magdeburg in 1872 by a high official of the English War Office. These quotations are given as examples of the fallibility of Herr Krüpp's representatives and representations as well as of his ordnance.

* *Vide* Beiheft zum 'Militair-Wochenblatt,' 1872, Zehnter Heft, page 139.

† *Vide* translation from the 'Revue Militaire de l'Étranger,' Printed Minutes of the Proceedings of the Royal Artillery Institution, No. 1, Vol. IX.

‡ The Vienna correspondent of the *Times*, writing under date June 1st, respecting 'the question of the remodelling of the field-gun, which can scarcely be delayed much longer,' observes :—'But, before all things, the War Department and Artillery Committee will have to decide on the system they wish adopted. The question is between the steel guns of Krüpp made according to the designs of the Artillery Committee, and the steel bronze of General Achatius. The cost seems the only remaining objection

unsettled, though probably on the point of ordering Krüpp pattern field-guns.

Russia has the Aboukoff breech-loader.

The only muzzle-loading rifled field-guns ever employed by any of these Powers have been bronze guns of types as completely obsolete as mere smooth-bores.

Contrast the position of these Governments with that of our own. We had, we might be said to have, a breech-loading system of field-artillery thoroughly elaborated and complete—its strength, safety, and efficiency undoubted, and even in its immature condition capable of good service in China and New Zealand. We tested it in the most crucial manner in 1863 and 1864, and elicited no weak point.* A

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to the first. About the second opinions are still very much divided, though the results of the experiments, as far as they go, show it to be scarcely inferior in accuracy and endurance to the steel guns, while it is considerably lighter. There are, indeed, erosions visible where the tin was not well alloyed with the copper, but these do not seem to interfere in the least with the precision or endurance; for in one case such erosions were seen after a few hundred shots, and yet the tube has stood over 2,000 shots with double charge and increased weight of projectile. Considering that in the campaign of 1866 not an Austrian gun fired above 70 shots, while in the war of 1870 the largest number of shots fired by a German gun was 260, this is no bad test of endurance.'

* The following is a passage from a letter recently published on this subject:—'It is assumed to-day that muzzle-loading came into fashion some years back, solely because we burnt our fingers with a particular system of breech-loading, I was at the time of transition a humble partisan of breech-loading for field and siege artillery, and a member of a committee which fired 20,000 rounds from rival breech-loaders and muzzle-loaders, and conducted trials

better might in these days be devised, but it is very doubtful that a better one exists. We have a muzzle-loader equally reliable, durable, and efficient, and it is certain that no other Government has or ever had a muzzle-loading field-gun of anything like equal value. Being free to choose between guns of equal powers, we have preferred the muzzle-loader. So small are our requirements, and so great our manufacturing power, that £80,000 and six months would again re-arm our entire field and horse artillery with any new pattern of gun desired. Assuredly, then, the state of the field-gun question at home, as compared with it abroad, affords us no justification for alarm or precipitation.

In regard to great guns a preliminary distinction must be drawn between the naval gun and the land or coast gun.

Armour-plating has reduced the number of our ships, and increased size of guns has reduced the number of our guns per ship. Such guns as are carried afloat must be fit for

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the most searching and exhaustive ever made, or likely to be made. I do not say that either the muzzle-loaders or the breech-loaders then used represented finality in guns ; but I do say that they presented adequate material for a judgment upon the relative merits of breech-loading and muzzle-loading for field and siege service, and that the Committee pronounced judgment upon the intrinsic merits of a case fairly submitted and thoroughly investigated. That they had no fault to find with the particular systems of breech-loading they had tested was shown by their recommending the breech-loading field-gun for boat-service, and the breech-loading siege-gun for casemates for flanking ditches, &c. If, then, the question of breech-loading field-guns is to be reconsidered, new data are not wanting so much as new opinions.'

continued and constant use in all quarters and under critical conditions. It becomes, then, all-important to select the best possible gun for sea-service, at any sacrifice of money or sentiment. But any number of guns may be mounted for coast or land defence, number gives the numerous chances required by stationary guns firing on moving objects, and number is therefore a consideration of much importance even compared with individual power. The larger number of such guns will, it is known, never be fired. Cheapness and home manufacture, therefore, become with some Governments elements of first-rate consequence in the selection of a land or coast gun. Again, it is to be observed that it is the naval gun that calls into being the coast-gun, and therefore the coast-gun question stands almost still pending the development of naval guns, especially also because, for the defensive purposes alone fulfilled by coast-guns, torpedoes have of late assumed a rival importance, and have, to a considerable extent, superseded coast-guns.

Thus, many considerations and causes have combined to put the naval gun in the first rank, as the gun in respect of which every Power has done its most and its best.

However, the Governments of England, Germany, Russia, and France do not seem to propose to adopt a different or second-class gun for coast if even for land defence, and so it may be laid down as fair and sufficient to compare the great guns of England with the patterns of heavy *naval* ordnance adopted by foreign Powers, and to

value the example of Continental Governments in relation to heavy ordnance according to their naval rather than to their military precedence and practice.

France, then, comes first for notice, and France claims no superiority for her naval ordnance. Her guns are, unlike ours, breech-loaders, but then France has not produced a successful heavy rifled muzzle-loader. Economy and home manufacture are the first considerations with France.*

Italy has the Armstrong muzzle-loading gun exclu-

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*Baron Henri Berge, colonel of the French artillery, was deputed by his Government during the summer of 1871 to visit England and Belgium, and study the systems of field artillery adopted by those countries, as representing in the greatest perfection the rival systems of muzzle-loading and breech-loading guns. His report concludes with suggestions as to the future gun for France: 'Two systems are before us—the English, which is derived from ours, and the Belgian—but neither could be introduced into France without modifications. None of our foundries are in a position to commence with absolute certainty of success the manufacture of *matériel* in steel. M. Krüpp, in spite of the perfection of his manufacture, would have been unable to conquer the prejudices of the Prussian artillery without the patronage of the King of Prussia. Even now the authority of his Royal associate does not free himself from attack. The Essen manufactory is subject, from time to time, to distrust. A 9-inch 8-ton gun burst this year at the Camp of St. Maurice; more recently still, an 8-inch 12-ton gun burst at Cronstadt. These have shown that there never can be absolute confidence in steel, and that it will never support heavy charges. The manufacture of the English gun gives the most complete security, but the price is not suitable to the actual resources of France.' Baron Berge's mission and report relate more expressly to field-artillery, but the above remarks are inserted here because they all apply *à fortiori* to the case of heavy guns.

sively, and takes the lead of the world in guns by building two ships, each to carry four 100-ton Armstrong guns.

Germany and Russia prefer the Krüpp gun, but it is noteworthy that, broadly speaking, they have had but one gunmaker, with but one gun to offer, and one set of experiments.

Austria has in great part Armstrong heavy muzzle-loading guns, but has reverted to the German gun, which is nearer home in many senses.*

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* Colonel Wilhelmi, Chief of the Marine Artillery Department in the Austrian War Office, has been the most conspicuous and influential and consistent advocate of the Krüpp system for Austria; nevertheless, in a report published in the 'Archiv für Seewesen,' March and May 1868, he makes the following considerable admissions:—'Krüpp's cylindro-prismatical wedge, with Broadwell ring, the best breech apparatus known up to the present time, requires for its manufacture uncommon mechanical appliances and great technical skill. Before every part of it is right, and works well enough for service, a great deal of time and trouble is required, and very little is enough to disable it, intentionally or involuntarily, for present use. The wedge, the ring, the gas-escape plate of one breech-piece and gun, cannot at once be used for another gun, so that only under certain suppositions would it be of any use to take duplicates of these and other parts of the breech apparatus, for the purpose of serving several guns in common. Some of the parts, especially the Broadwell ring, are subject to the weakness of losing immediately, by rough handling, those properties without which they do not act. To keep the breech-piece in order, in such a way that it may at all times be used without any delay, renders compulsory many precautions in the daily cleaning, especially, as regards the material, of polishing and preserving, and demands, at least on the part of the captain of the gun, the knowledge of how to put the apparatus

Spain has the Armstrong muzzle-loading gun.

Holland, Denmark and Norway, Portugal, Turkey and Egypt, Chili, Peru, and the Argentine Confederation, all have thus far adopted for their fleets the Armstrong gun. Brazil has English guns exclusively, in part Whitworth, and in part Armstrong. The naval gun question is to most of these Powers, as to us, of vital importance, and their expenditure upon guns has been relatively very large. They have, each and independently, brought to bear upon their choice of a naval system of ordnance as much zeal, intelligence, and impartiality as France, Germany, or Russia. They

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together. On board ship, more than anywhere else, on account of the damp, it is difficult to prevent the rusting of the surfaces which are to be kept bright, and uninterrupted attention must be paid to the gun from this cause alone ; but where there is a great deal of scouring there is a good deal of wear. In the event of the Broadwell ring not closing the breech particularly well, both the ring and the plate must be wiped clean after every shot, which is not easy to do when the wedge is in the position for loading, and can therefore only be done imperfectly. In such case it will be more frequently necessary to bring out the wedge to the end of the groove ; but this will involve a loss of time, which time may possibly be invaluable. . . . . Although only three movements are necessary to open, and as many to close, the possibility is not excluded of one of these movements being forgotten in the heat of battle. If this oversight occurred in closing—we mean an omission in pushing to the locking-bolt—the breech would not be closed ; on discharge the gas would rush violently out, the respective surfaces would be so fouled that they would require a thorough cleaning, and—which would be the worst part of the matter—this oversight might possibly lead to the breech-piece being blown out, which would be equivalent to putting the gun *hors de combat*.'

have been, perhaps, less fettered in their choice. They have all preferred the English muzzle-loading heavy guns. The balance, then, of free and skilled opinion in Europe, taking the naval gun as the test, is largely on the side of the British service heavy gun; and it may be fairly said that, so far from our standing in alarming isolation, as some suppose, the involuntary verdict of Europe is in our favour.

But the case does not rest here. It is not enough to say that there is no foreign heavy gun in existence which is superior to our own, either in fact or in the general opinion of Europe. So weak and doubtful is the evidence as to the security and durability of even the best and most tried foreign heavy ordnance, that it is not too much to say that this country could under no circumstances accept any existing foreign gun were it wholly without one of its own.

Lord Cardwell, in the recent debate in the House of Lords upon the Duke of Somerset's motion, laid it down that if a system of ordnance gave one bad gun to ninety-nine good guns, that system was an inadmissible system. But by this standard the Krüpp heavy gun, the only possible foreign gun, is hopelessly condemned and far beyond reprieve.

The secresy observed abroad in regard to failures makes it impossible to produce officially authenticated evidence of many failures, and hard to learn the whole number of them. But the foreign artillerists do not hide a single success and thus we know, at any rate, the case in favour of their guns. And this is what we know: we

know that Captain von Doppelmair,* the ablest apologist of the Krüpp system, could in 1869 produce only seven instances of heavy Krüpp guns that had shown a fair durability—shown under most careful nursing, in experiments, not on service, and chiefly within the parent factory. Of these seven, four, he admits, were of the solid steel block structure, which is further admitted to be utterly untrustworthy.

To set against these seven examples of fair endurance, we have the admission of Herr Krüpp's agent, in his letter to the 'Times' of May 17, 1875, that within his knowledge seventeen Krüpp guns have burst, of which six are heavy guns.

Our own official confidential reports are known to furnish evidence of more failures of Krüpp guns than are here admitted by Mr. Longsdon; but what more evidence is wanting for the condemnation of the Krüpp system by Lord Cardwell's ruling than Captain von Doppelmair and Mr. Longsdon have themselves supplied?

Where, then, is the need to scare the country with this new Frankenstein? Where is the sense of decrying our own ordnance? It may be that the official world can now and again be whipped and the public warmed to the work of gunnery with advantage. It is certain that we

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* A Critical Comparison, &c., by C. von Doppelmair, in the second number of the 'Russian Artillery Journal' for 1869, translated by G. H. Penton. London: Read, Brooks and Co., 1870. Pp. 72, 74.

must keep the lead and borrow from abroad, if need be, just as Krüpp borrowed from us when beaten by us at the first encounter at Tegel. But popular agitation is not needed in order to keep artillery science alive, while it is well calculated to discourage, to confuse, and to undo it.

Consistency and continuity of artillery experiment and investigation are essential to any practical advance; and perseverance in perfecting a system and in training men in its use is not only absolutely necessary for the success of the best possible system—it is also probably more than a compensation to any good system for any slight theoretical inferiority which indulgence in perpetual indecision and discussion could elicit.

III.

Assuming then that the gun we have is not a bad gun, and that the gun of no foreign Power is better, it remains to be enquired whether there is a still superior gun which is attainable, and which we yet wilfully reject.

Now many people believe that we, at any rate, wilfully reject the best material for our guns.

Steel has displaced wrought-iron for so many uses, it has made so many reputations and so many fortunes, and has consequently so many friends, that there is necessarily a strong body of technical as well as of popular

opinion on its side. Nor would any competent artillerist deny that excellent guns have been made of steel, or affirm that steel can never become the gun-metal of the future.

One or two general considerations, however, should suffice to satisfy the outside world that the reluctance of our Ordnance officials to accept steel is most natural as well as wise. Look at the existing Ironclad—it is one prodigious mass of wrought-iron. Why not of steel, if steel be better? If the armament should be of steel, why not the armour? *—why not the boiler? The arguments which

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* When Sir William Armstrong observed the great increase of tenacity imparted to steel by the system of cooling or tempering in oil, he at once proceeded to manufacture a sample armour-plate of oil-toughened steel, in the hopes that steel thus treated might realise its theoretic value as an armour-plate. Before shot-proof the plate had given evidence by every known test of qualities far exceeding in every respect anything reached by wrought-iron. Pieces cut from it and tested under statical pressure had shown extraordinary tenacity and ductility in combination with the superior hardness of steel. In short, the plate, while retaining the special advantages of steel, appeared to possess in a higher degree than wrought-iron all those qualities which mechanics recognise as giving peculiar value to wrought-iron. Yet this plate when fired at cracked at the first round, and broke in pieces at the second. Inexplicable as the fact may be, it appears that while steel presents greater resistance to static strain than wrought-iron, it is inferior to wrought-iron in resistance to concussive strain, even when of a quality proved by every ordinary test to be remarkably ductile. Apart, therefore, from its uncertainty, as being a material liable to flaws and defects which cannot be welded out of it, steel is still as yet specifically inferior for certain purposes to wrought-iron.

restrain or render cautious the naval architect, in regard to steel, are such, and such only, as affect with even greater force the artillerist. The production of steel ships, steel boilers, steel engines, and steel armour should by every law of logic precede the production of steel guns,* for steel can do more for the ship than for the gun. It can revolutionise the armour-clad, but to the gun it can render small service. To reduce weight while retaining strength is, with the armour-clad ships, to acquire the power of increasing either the defensive or offensive power, the speed or coal capacity of the ship, until the saving in weight is expended.†

But the facts are, that though steel has been sparingly introduced for ten years past into certain portions of the structure of Her Majesty's ships, those ten years have seen but very slow progress towards its more general application. Not one of our ships of war contains a single steel boiler, and it need hardly be said that no armour-clad is protected

* That is to say, in any country which (like our own) is not driven to the use of steel for guns from want of power to make them of wrought-iron on the Armstrong principle.

† A comparison of the weights of existing wrought-iron and steel ordnance will show that there is no practical, even if there be any theoretical, saving of weight by the use of steel for guns. Further, if the guns were lighter the carriages would have to be strengthened—that is, made heavier—to meet the greater strains of recoil. Moreover, the weight of the guns is so insignificant compared with the weight of the ship, that the advantage to be derived from lightening them would be imperceptible to the ship, whereas a saving of one per cent. upon the weight of the ship would generally equal in amount the entire weight of the guns of the ship.

by steel plates. Yet steel should not only have been adopted and applied for such uses, it should have been thoroughly tested and completely triumphant before being accepted by the artillerist, who, in the first place, has to his hand so good a material that he could only be justified in changing it on indefeasible evidence that a better is to be had; and in the next place is entitled to regard steel with the utmost reserve and suspicion, because its notorious defect is its caprice, and caprice is just the one defect that the artillerist is bound to treat as fatal. Nor is it sufficient to point to a new invention or new method of manufacture to establish a case in favour of steel for guns. Interesting arguments may be heard in favour of compressed fluid steel, and interesting experiments made; but the consideration urged in reference to steel generally applies to any kind of steel, however promising it may seem. Apart altogether from the question of Artillery, the production and use of the best possible steel is a matter of the deepest commercial interest to the country. There are a multitude of uses for which the highest quality of steel, at whatever price, is so urgently demanded that nothing could keep it back, and the public may assuredly leave it to the open market to assess the true value of any and every kind of steel.*

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* It must not be forgotten that steel and wrought iron are so closely allied that hitherto the distinction between them has escaped definition. Practically they are distinguished by their properties; yet in their properties they also gradually approach one another until all difference vanishes. Therefore the argument

To give up an excellent and tried material on the chance of finding something better in one which, however promising in appearance, has given no proof of the substantiality of that promise, would be truly to act like the dog in the fable that dropped the food out of its mouth for the sake of a visionary morsel.

Many of those who advocate steel as the material for all ordnance, advocate also breech-loading in preference to muzzle-loading. Here, again, some technical men and mechanics of eminence may be found in favour of change. Having a general faith in the future of steel, a general notion that the breech-loader is the more advanced form of gun, and a natural desire for further triumphs of mechanical skill in gunnery, they speak lightly of our ordnance, and pass judgment with the usual readiness and ease of irresponsible on-lookers. This discounting of the future of artillery has an air of foresight and sagacity, but it is fruitless, of course, and may well be fallacious.

Yet, even so, the partisans of breech-loading for field service might not be strong enough to gain the attention

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used above against steel diminishes in force according as the steel in question approaches wrought iron in quality; but so also diminishes *pari passu* the argument in favour of steel and against wrought iron.

The Admiralty recently prescribed that certain steel to be supplied to them should *not exceed* a fixed and low tensile strength; thus treating the very quality for which steel is most distinguished as an evil to be restrained, rather than an advantage to be sought.

of the public at this moment, but for the adhesion to their ranks of a distinguished outside inventor.

Sir Joseph Whitworth has come forward as the proposer of a breech-loading fieldpiece. In 1864, when our field-guns were breech-loaders, Sir J. Whitworth was the pronounced partisan of the muzzle-loading ordnance. It may indeed be argued, that it was his alliance with the advocates of the muzzle-loader that at that date brought about the exhaustive series of trials which ended in the displacement of our breech-loading field-artillery by the present muzzle-loaders.*

It would be strange if, by a new combination of parties, Sir J. Whitworth could succeed in bringing about a new trial of the question, with the view of reversing the verdict he was so largely instrumental in procuring. And it may be safely predicted, that should the old issue of breech-loading

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* Sir Joseph Whitworth informed the Parliamentary Ordnance Committee of 1862-63, emphatically, that he was not a partisan of the breech-loading gun. (*Vide* Ordnance Blue Book, No. 487, p. 107.) In his letter of December 25, 1862, to the then Minister of War, he dwelt on the fact that his guns are muzzle-loaders, and that Sir W. Armstrong's guns are breech-loaders, and takes for granted that in the then forthcoming competition Sir W. Armstrong will be confined to the use of breech-loaders. (*Vide* Appendix to Evidence, Armstrong and Whitworth Committee Report, p. 157.) The Committee in their Report observe, that 'the guns submitted by Mr. Whitworth are muzzle-loaders; and 'although he has made some of his guns as breech-loaders, he 'stated that he has always advocated the muzzle-loaders, pre-'ferring them as being more simple and equally quick in loading.'

versus muzzle-loading be re-tried, and a re-transformation of our field-gun follow, he will find himself as before, for all his pains, still unable to carry into our service the well-known form of rifling which twenty years of experiment and twenty Committees have failed to establish in this or any European country.

It is perhaps to be expected that, with his indomitable perseverance, Sir Joseph Whitworth should take advantage of any slight reaction towards breech-loading, and of any new sensitiveness of the public mind arising from German successes, to again bring forward his rifling and his steel under cover and guise of a small breech-loader. But, apart from this circumstance, there probably exists no greater excitement in regard to breech-loading for field-artillery than a few firm words of conviction on the part of the best-informed and from the right spokesman could readily allay. No policy, surely, could be more aimless and barren than that of trying alone the particular breech-loader which Sir J. Whitworth is now bringing bodily within both Houses of Parliament. That would be to revive and mix up the worn-out controversies about the Whitworth system of ordnance with what has no sort of connection with them—viz., the best method of breech-loading for field-pieces. If breech-loading is indeed deliberately desired for field service, the only practical and effective course would seem to be—as in the analogous case of the small-arm—to invite world-wide competition, and to make open and exhaustive trials of every method submitted which shall appear worth the outlay.

The question of breech-loading, as it relates to heavy ordnance, is a much more serious one ; and there is grave economical reason for demanding the establishment beyond question of a weighty case in favour of the heavy breech-loader, before undertaking the immense expenditure involved in such thorough and practical investigations as must necessarily precede definite action by the country.

That there is no weighty case in favour of breech-loading generally, for heavy guns, it has been sought to show in earlier pages ; yet it may be fairly alleged that breech-loaders have a specific advantage for specific positions—for instance, that they enable narrow-waisted ships, if armed on the broadside principle, and also certain already-constructed casemated forts, to carry* more powerful guns.

Assuming that, on the broadside, breech-loaders would prove more economical of space, it must be remembered that for turret and central guns the muzzle-loader has a distinct advantage over the breech-loader in economy of space, if mechanical loading be, as it must be, adopted.†

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* The long naval-service Krüpp 9-inch gun measures 17·15 feet in length. The 10-inch gun of our service is 14 feet $2\frac{3}{4}$ inches long without the cascable ring. The total energy of the Krüpp 9-inch gun is 3,657 foot tons, and of the English 10-inch gun 5,160 foot tons. As a matter of fact, there are several iron-clads afloat which carry the 10-inch Armstrong gun, but could not carry Krüpp guns of equal power.

† The 38-ton guns of the 'Thunderer' are $19\frac{1}{2}$ feet in length ; the diameter of the turret is $24\frac{1}{2}$ feet. The 81-ton gun of the

So also with earthworks and casemates, muzzle-loaders will now have the advantage of requiring less space for working than breech-loaders, except in some instances, which may never be repeated. Hard cases make bad law, and it certainly would seem wild work to unduly press the breech-loading question for heavy ordnance generally, on such occasion for it as can at present alone be shown.

The proposal to settle the question by the immediate trial of a Krüpp heavy gun* seems as onesided and incomplete as can well be imagined. A cursory examination of the method of breech-loading adopted by Herr Krüpp, for small and great guns alike, will go far to show that that method, however satisfactory for small guns, is objectionable in heavy guns, because it involves a considerable and useless prolongation of the bore backwards, and a hole, or wound, of much greater size than the bore, and transverse to it, right through both walls of the gun.

On the other hand, the breech mechanism adopted by the French for their heavy guns avoids both these evils, and presents none peculiar to itself; while it is applied so

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'Inflexible' is 27 feet in length; the diameter of the turret is 27 feet. The 100-ton guns of the Italian ships are 33 feet long, and the diameter of the turrets is 27 feet. There is no plan or proposition extant for mounting breech-loaders of equal length in spaces so contracted.

* Some time ago our War Office failed in an attempt to obtain a heavy gun from Herr Krüpp, who declined to submit a sample to the ordeal of English trial. Had the War Office then succeeded, we should have indulged in a reasonable curiosity at a comparatively moderate expense.

largely, and to such important guns,* and with so fair a measure of success, as to deserve, in a very high degree, the attention of this country.

But the purchase of French and German heavy breech-loaders alone would not suffice. The artillerists of this country have earned the right to compete, here at least, with France and Germany. Then would come the question of the size and power to be fixed for the competing breech-loaders; and seeing that 100-ton muzzle-loaders are being made, the question of breech-loading could hardly be tested in guns of much inferior power and weight, for a cardinal point in the inquiry would be the applicability of breech-loading to the heaviest guns likely to be in use and brought against us. Our Ordnance officials may, perhaps, be forgiven, by Parliament and the country, if they have shrunk from experiments and expenditure so gigantic.

And if a general change of system of loading for heavy ordnance be not required, if the cases in which breech-loaders may have the advantage are admitted to be relatively few, then what need is there for spasmodic effort, Parliamentary agitation, attack upon our guns, concession to foreign artillery? The progress made in this country in the production of heavy breech-loaders is not small, and will certainly not cease even though Parliament should be inactive. The Elswick firm, some years ago, produced a

* The 38-ton 12½-inch French breech-loader is, next to our own gun, the most powerful piece of ordnance in any Service.